Ecological Impact/Transport and Transformation of Perchlorate

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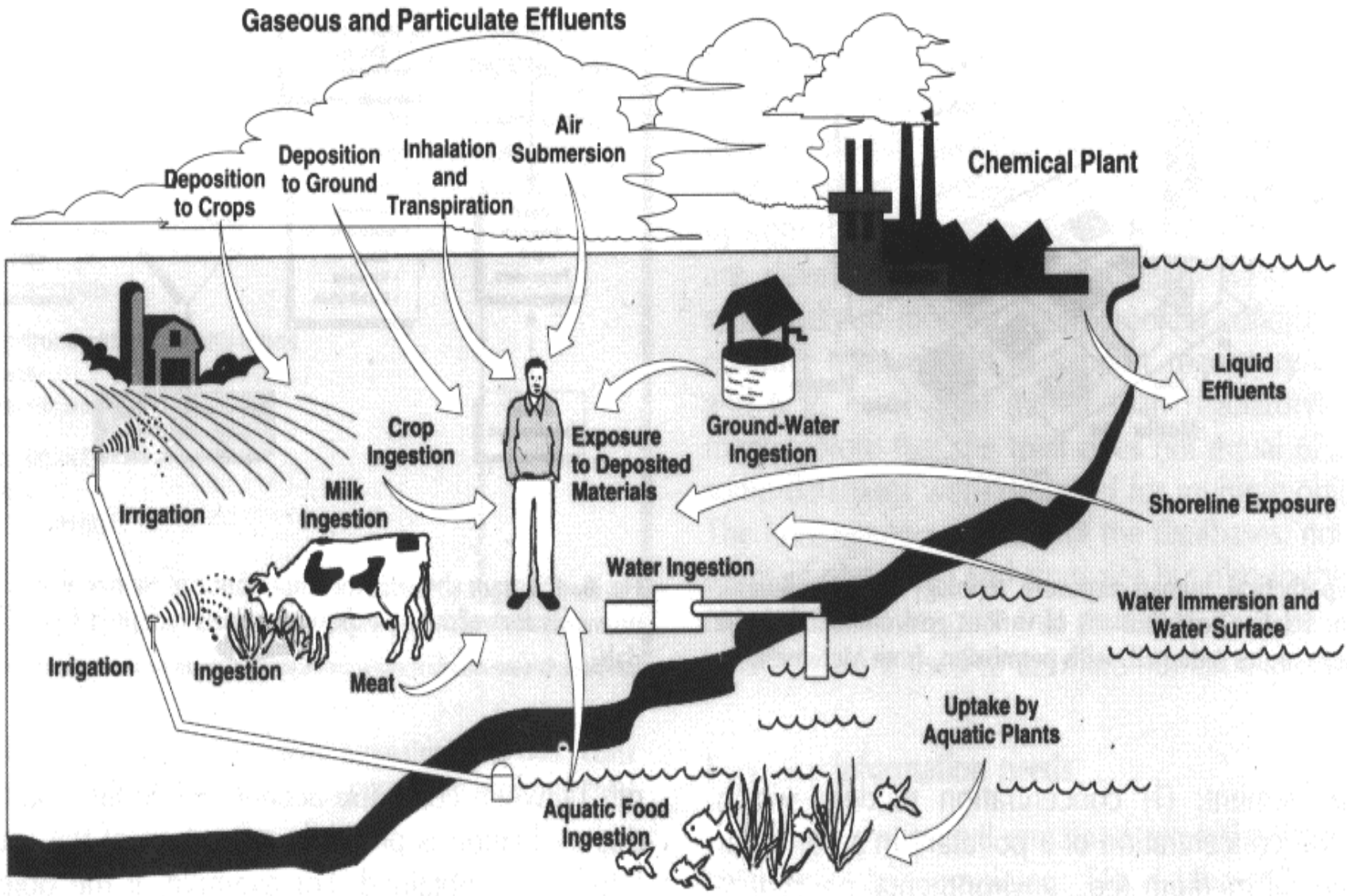
Introduction

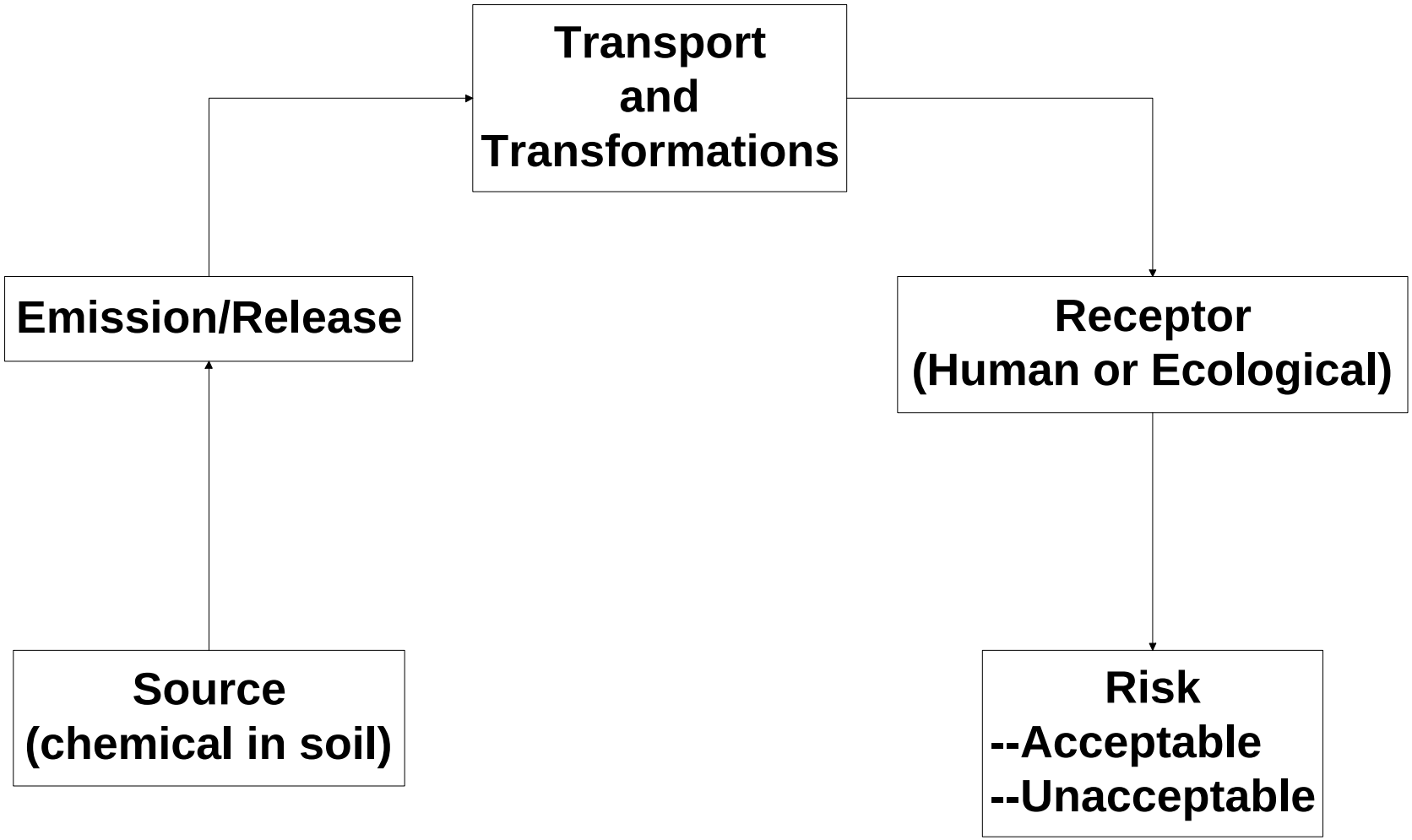
- Background
- Fate and Transport of perchlorate
- Historical Studies
  - Potential ecological receptors
  - Observed Effects
- Proposed Activities and EPA Framework
- Discussion

Background

- Perchlorate salts have low volatility, but high solubility
- Solubility leads to high mobility in aqueous systems
  - Surface water
  - Groundwater
- Mobility and persistence may pose a threat to ecological receptors


Gaseous and Particulate Effluents
Deposition to Crops
Deposition to Ground
Inhalation and Transpiration
Air Submersion
Chemical Plant
Liquid Effluents
Crop Ingestion
Exposure to Deposited Materials
Ground-Water Ingestion
Irrigation
Milk Ingestion
Shoreline Exposure
Water Ingestion
Water Immersion and Water Surface
Irrigation
Ingestion
Meat
Uptake by Aquatic Plants
Aquatic Food Ingestion

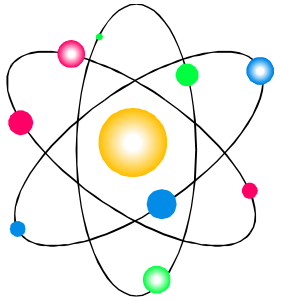
Exposure Model



Fate and Transport

(Transport and Transformation)

- What happens to perchlorate in the environment?
  - Physical characteristics
  - Attenuation processes
- What are the data gaps?



Physical Characteristics

- Vapor Pressure--no values found in literature
  - Volatilization not expected to be predominant pathway
- Density--1.95 g/mL
  - Will sink in water
  - Concentrated solutions also more dense than water

Physical Characteristics

- Solubility--20.2 g/100g solution
  - Dissolution expected and perchlorate ion will predominate in solution
  - Potential for potassium salt to precipitate--function of ion concentrations
- Standard potential--reduction for Cl from +7 oxidation state to -1
  - All values positive which indicates the reaction is thermodynamically favored

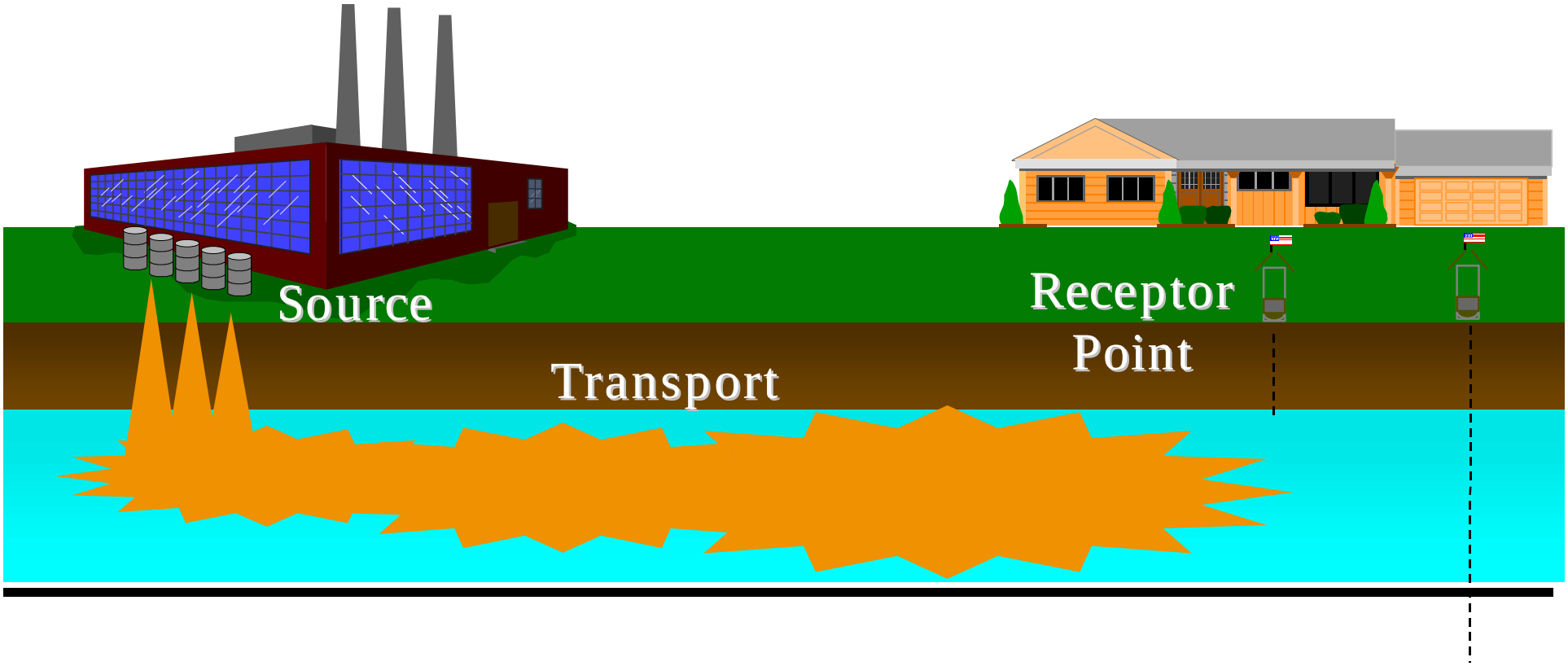
Physical Characteristics

- Standard potential

$$ClO_4^- + 4H_2 \longrightarrow 4H_2O + Cl^-$$

  - Little evidence that reaction occurs spontaneously
  - Reduction rate negligible at room temperature
  - Conclusion: Perchlorate is kinetically stable (most stable oxo-compound of chlorine)

Mobility of Perchlorate



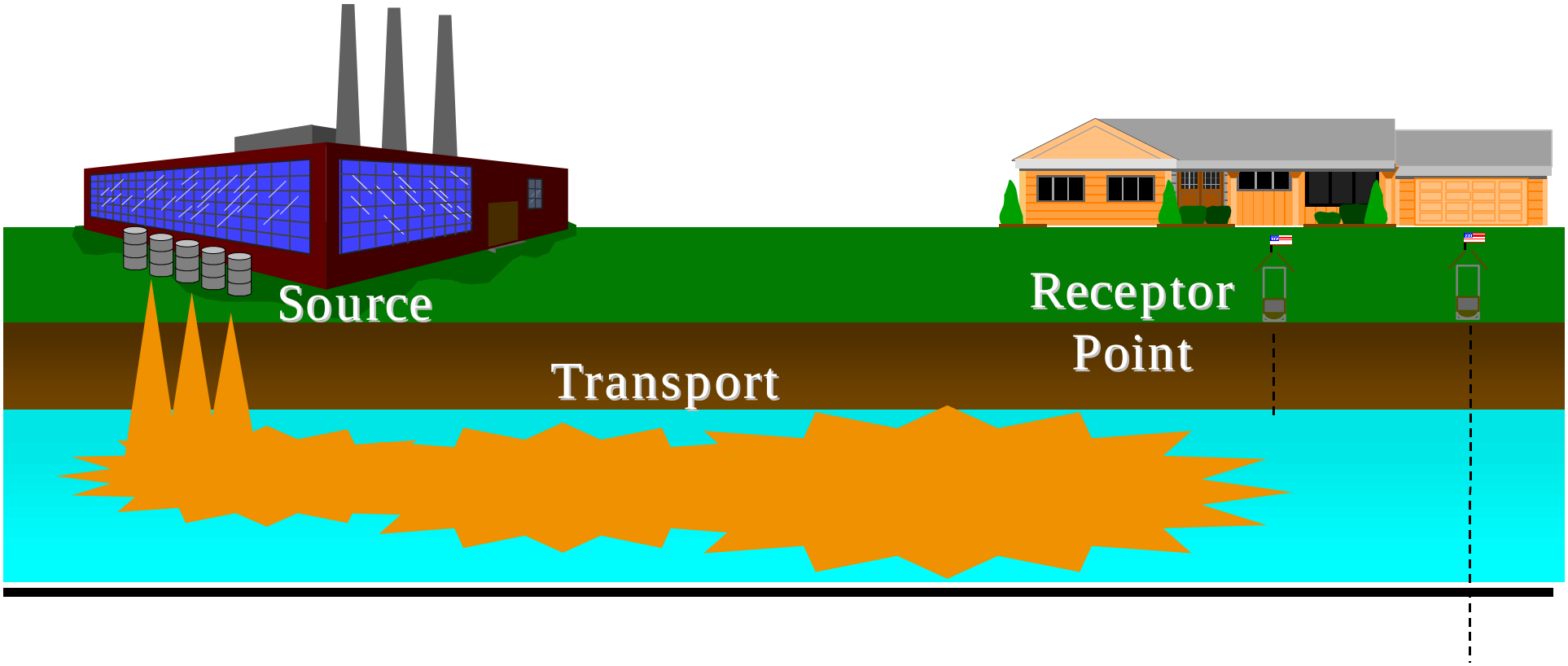
Attenuation Processes

- Dilution
- Precipitation
- Biological or chemical reduction
- Adsorption
- Ion-exchange

Attenuation Processes

- Dilution--concentrations expected to be significantly lower away from the source
  - However, function of the inert binder may influence source area concentrations
- Precipitation
  - Potassium less soluble, could lead to subsurface precipitation; long-term source area, near source area, and far source area re-dissolution

Mobility of Perchlorate



Attenuation Processes

- Biological or chemical reduction
  - Perchlorate reduction can occur at metal surfaces under acidic pH; however, inhibition by competing anions a problem
- Sorption
  - Perchlorate absorbs weakly to most soil minerals (NO_3^- and Cl^- more favorable)
  - Minimal impact inhibiting mobility

Summary

- Perchlorate is very soluble
- Very stable at low concentrations
- Very inert ion
- Some potential for precipation in subsurface
- Reduction and sorption occurs to a lesser extent

Data Gaps
General

- Binder Effects
  - Binder chemical degradation rates?
  - Leachability from binder?
  - Concentration of binder + other contaminants?
- Role of reduction and interaction of $Cl0_4$ with subsurface soils

Data Gaps
Site-Specific

- Soil properties
- Hydrology
- Infiltrating groundwater
- Characterization of leachates produced from source and near source soils

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